

**GROUND-WATER QUALITY  
ASSESSMENT PLAN  
P.H. Robinson Generating Station**

SWR 31638

TXD0000837401

**For**

**Houston Lighting & Power Company**



**Underground Resource Management, Inc.**

**Austin, Texas**



Underground Resource Management, Inc.

October 21, 1983

J83-883

Mr. Edward A. Feith  
Principal Water Resources Engineer  
Environmental Protection Department  
Houston Lighting and Power Company  
P. O. Box 1700  
Houston, Texas 77001

Dear Mr. Feith:

We are pleased to submit under cover of this letter the Ground-water Quality Assessment Plan for the P. H. Robinson Generating Station.

Should you have any questions concerning the plan, please contact me.

Sincerely,

*Bob Kent*

Bob Kent  
Vice-President

BK/rgb  
Attachment





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For  
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By  
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## TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION. . . . .	1
P. H. Robinson Facility. . . . .	1
Permitting Summary . . . . .	1
RCRA Requirements. . . . .	2
SITE DESCRIPTION. . . . .	4
Topography . . . . .	4
Geologic Setting . . . . .	4
Hydrogeologic Setting. . . . .	5
Regional Ground-water Quality. . . . .	7
P. H. ROBINSON GROUND-WATER MONITORING PROGRAM. . . . .	8
P. H. Robinson Facility. . . . .	8
On-site Observations . . . . .	8
GROUND-WATER ASSESSMENT PLAN. . . . .	13
Ground-water Characterization. . . . .	13
Ground-water Levels . . . . .	13
Area Use Characterization . . . . .	13
Well Stimulation . . . . .	14
Sampling . . . . .	15
Well Sampling . . . . .	15
Ponds and Other Surface Water Samples . . . . .	15
Hydrologic Testing Details . . . . .	17
Shallow Aquifer . . . . .	17
Recovery Test. . . . .	17
Pump-in Test . . . . .	17
Test Results. . . . .	17
Deeper Aquifer. . . . .	18
Rates and Direction of Movement . . . . .	18
Geologic Cross Sections. . . . .	18
IMPLEMENTATION SCHEDULE . . . . .	19
FINAL REPORT AND RECOMMENDATIONS. . . . .	21



### LIST OF TABLES

	<u>Page</u>
Table 1 - Well Completion Summary. . . . .	10
Table 2 - Significant Increase Statistical Data. . . . .	11
Table 3 - Ground-water Assessment Program Time Table . . . . .	20

### LIST OF FIGURES

Figure 1 - Stratigraphic and Hydrologic Units . . . . .	6
Figure 2 - Robinson Generating Station. . . . .	9

### LIST OF APPENDICES

Appendix A - Ground-water Monitoring Requirements for Hazardous Waste Facilities During Interim Status	
Appendix B - Analytical Methods	





## INTRODUCTION

### P. H. Robinson Facility

The P. H. Robinson Generating Station, owned by Houston Lighting and Power (HL&P), is an electrical generating station located west of San Leon in Galveston County, Texas, between Galveston Bay and Dickinson Bay. The facility uses seawater as a source of water for cooling, and then blows it down after one cycle. There are two ponds currently meeting the ground-water monitoring and reporting requirements of the Texas Administrative Code (TAC), Sections 335.191-335.195. These ponds serve as retention facilities for the demineralizer regeneration waste fluids.

### Permitting Summary

TAC Section 335.191 requires operators of hazardous waste facilities to develop and implement a ground-water monitoring program for their facilities or obtain a waiver for monitoring requirements. HL&P developed a self-implementing waiver for this facility dated November 16, 1981. The waiver was reviewed and rejected by the Texas Department of Water Resources (TDWR) by a letter dated May 25, 1982. Accordingly, HL&P contracted with McClelland Engineers to develop a ground-water monitoring system and install monitor wells. Sampling and reporting requirements specified by TAC Sections 335.193-.195 are outlined in Appendix A. After installation in July, 1982, samples were collected on July 23, 1982, August 26, 1982, October 13, 1982, and December 13, 1982 to complete the quarterly sampling requirements. The results of these analyses were reported to the TDWR. On May 23, 1983, the first semi-annual samples were collected. Pursuant to TDWR rules, the semiannual samples were compared to the previous years' results. When comparing the "downdip" samples to the "updip" samples, using the Student's t-test, several wells failed the test. Accordingly, HL&P resampled and reanalyzed to determine if a sampling error has been made. The



results of the analyses confirmed a statistical difference in the down-gradient wells. Accordingly, HL&P notified the TDWR by a letter dated August 31, 1983. Underground Resource Management, Inc. (URM) was then retained to prepare the required Ground-water Quality Assessment Plan.

#### RCRA Requirements

HL&P has complied with TAC 335.192 by installing a background water quality (updip) monitor well and three wells hydraulically down-gradient from the waste management area. Since the waste management area consists of several retention ponds in close proximity, there are only four wells [335.192(a)(b)]. Pursuant to TAC 335.193(a)(b)(c)(d)(e), HL&P has collected and analyzed fluids from the aforementioned water wells. A significant increase in a down-gradient well has been verified as required by TAC 335.194(c)(2), and notification given as stipulated by TAC 335.194(d)(1).

This document outlines a Ground-water Quality Assessment Plan as required by TAC 335.194(d) and contains the necessary inputs to meet the following requirements:

<u>TAC Section</u>	<u>Requirement</u>
335.194(d)(3)	
(A)	The number, location, and depths of the wells,
(B)	Sampling and analytical methods for those hazardous wastes or hazardous waste constituents in the facility,
(C)	Evaluation procedures, including any use



of previously gathered ground-water quality information; and

(D)

A schedule of implementation.

335.194(d)(4)

The plan must determine:

(A)

The rate and extent of migration of the hazardous wastes or hazardous waste constituents in the ground water, and

(B)

The concentrations of the hazardous waste or hazardous waste constituents in the ground water.

The assessment program as outlined will address the determination of whether hazardous wastes or hazardous waste constituents have or have not entered the ground water [TAC 335.194(d)(6) or (7)].

By definition, for the hazardous waste streams managed within the facility, only pH would be considered as a hazardous waste constituent (CFR Section 261), and therefore, the statutory requirement for the Ground-water Quality Assessment Program [TAC 335.194(d)(4)] would be to determine the rate and extent of migration of pH. Realistically, an assessment of ground-water quality impact at this facility should address the presence of inorganic constituents. Accordingly, this objective has been incorporated into the Ground-water Quality Assessment Plan outlined herein.





## SITE DESCRIPTION

### Topography

The P. H. Robinson Generating Station is situated in a flat, low-lying plain <sup>west</sup> east of Galveston Bay and north of Dickinson Bay. Cooling water is once-through saltwater. The intake side is via a channel from Dickinson Bay and the discharge side is via a channel into Galveston Bay. The site elevation is approximately 12 feet above mean sea level (MSL).

### Geologic Setting

The shallow deposits (less than 100') which underlie the P. H. Robinson facility are the Beaumont Formation of Pleistocene age. They consist of unconsolidated, complexly interwoven clays, sandy clays, sands, and occasional gravels. The sediments were laid down as part of a fluvial-deltaic system which is thought to have been deposited during a sea level high stand during the Sangamon interglacial period. Coarser sediments are distributary and fluvial sands, silts, and gravel including crevasse splay deposits. The distributary sand bodies are elongate, sinuous, and generally oriented in the direction of the dip. Finer sediments, including clays and clayey sands, were deposited in lower-energy interdistributary areas including bay, flood basin, and locally abandoned channel facies.

The facility is located on predominantly clays and muds with low permeability, high water holding capacity, high to very high swell potential, poor drainage, low shear strength and high plasticity. These sediments represent subaerial muddy deposits including floodplain muds, interdistributary deposits, and marsh and swamp facies.

Soil borings at the site indicate that the near-surface geology is



approximately 11 feet of light to dark-gray to red and tan clay overlying approximately 9 feet of tan, red, and light gray sandy clay overlying a 9-foot tan and light-gray slickensided clay which becomes sandy towards the bottom. Below this unit is a tan, silty, fine sand approximately 10 feet thick which overlies a stiff, tan, and light-gray slickensided clay.

#### Hydrogeologic Setting

The water-bearing stratigraphic units in the Texas Gulf Coast consist of interbedded sands and clays which cannot be traced very far in the subsurface. The sand units are hydraulically connected to each other, and ground water moves both horizontally and vertically from one sand to another.

The facility is underlain by three aquifer systems indicated on Figure 1. Of the three aquifers, the lower portion of the Chicot provides most of the ground water used in southeastern Harris County and in Galveston County. The Evangeline Aquifer provides most of the ground water used in the Houston area.

As indicated on Figure 1, the upper Chicot is comprised of the Beaumont Formation on which the facility is sited. The Beaumont predominantly consists of low permeability clays with irregular sand and silt lenses. In some areas, these shallow sand and silt lenses will provide small quantities of ground water to individual domestic supply wells at typical subsurface depths of 70 to 100 feet. It is unknown at this time whether ground water is produced from the Beaumont within one mile of the plant. The shallowest known production of ground water within the vicinity of the plant occurs at a depth of 565 feet from the Evangeline Aquifer.



ERA	SYSTEM	SERIES	STRATIGRAPHIC UNITS		HYDROLOGIC UNITS	APPROX. DEPTH IN PROJECT AREA		
CENOZOIC	QUATERNARY	HOLOCENE	ALLUVIUM		CHICOT AQUIFER	650-		
		PLEISTOCENE	BEAUMONT					
			MONTGOMERY					
			BENTLEY					
			WILLIS					
	TERTIARY	PLIOCENE	GOLIAD		EVANGELINE AQUIFER <i>Base of usable quality water (&lt; 3000 mg/l)</i> BURKEVILLE CONFINING ZONE	2800-		
		MIOCENE	FLEMING FORMATION				JASPER AQUIFER	
					SURFACE			SUBSURFACE
					CATAHOULA FORMATION	UPPER CATAHOULA		
						ANAHUAC		REGIONAL CONFINING ZONE Heterostegina Zone
			UPPER FRIO			6500-		
			BASAL FRIO					
			OLIGOCENE	JACKSON GROUP		VICKS BURG		REGIONAL CONFINING ZONE

After Baker (1978)

Figure 1. Stratigraphic and Hydrologic Units



### Regional Ground-water Quality

The lower Chicot and Evangeline Aquifers produce water in the area of the facility with total dissolved solids (TDS) concentrations in the range of 200 to 900 mg/L. In the immediate area of the plant, ground water produced from intervals ranging from 565 to 664 feet has been reported to be in the range of 704 to 872 mg/L TDS.

The shallow sands and silts of the Beaumont Formation typically contain fresh to brackish water with TDS concentrations frequently in excess of 1000 mg/L.





## P. H. ROBINSON GROUND-WATER MONITORING PROGRAM

### P. H. Robinson Facility

As required by TDWR TAC 335.192, 335.193, and 335.194, HL&P has installed and sampled four monitor wells. These wells are located on Figure 2 and their completions are listed in Table 1.

Fluids yielded from Monitor Wells #2, #3, and #4 during the first semiannual 1983 sampling indicated a statistical significant increase (or decrease) for conductivity. Well #4 also had a statistically significant increase for pH and TOH. The statistical significant increase was determined using the T-Statistical Test. The wells were resampled and statistical significant increases were verified, except the Well #4 TOH parameter. The verification required the preparation of the Ground-water Quality Assessment Plan under TAC 335.194(d)(1) and (2). Table 2 lists the statistical data for the wells.

### On-site Observations

The P. H. Robinson facility has two retention ponds currently in operation subject to TAC 335.191-335.195 requirements. These clay-lined ponds receive demineralizer regeneration wastes from the boiler make-up circuit.

A review of chemical analyses from these ponds indicates there are no EP toxicity metals or organics present above detection limits except barium in the inorganic and organic acid liquid, sludge wastes, and the demineralizer regenerant liquid and sludges wastes. These results appear to be consistent with monitor well data reported by HL&P, which also indicates the absence of heavy metals and organics in samples collected from their ground-water monitoring wells.



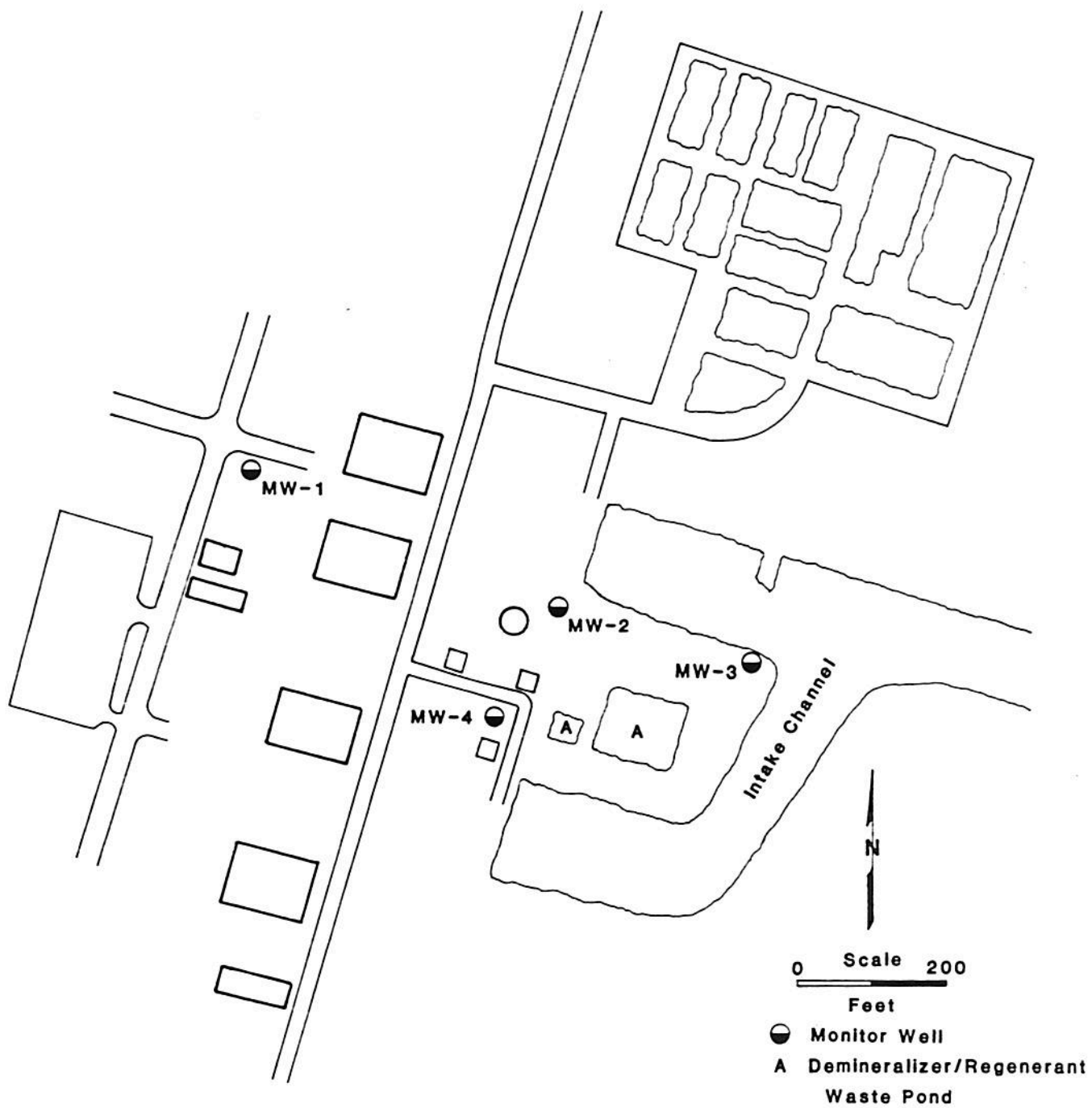


Figure 2. Robinson Generating Station



TABLE 1\*  
Well Completion Summary

<u>Well No.</u>	<u>Location**</u>	<u>Depth Feet Below Ground Level</u>	<u>Screened Interval Feet Below Ground Level</u>
1	Uddip	45.2	39-44.2
2	Downdip	43	37-42
3	Downdip	43	37-42
4	Downdip	43	37-42

\*This data required by TAC 335.194(d)

\*\*Locations to be verified as part of the Ground-water Quality Assessment Plan



TABLE 2  
Significant Increase Statistical Data

<u>Well No.</u>	<u>Parameter</u>	<u>Background</u>	<u>1st Semi-Annual (1983)</u>	<u>T-Statistical</u>	<u>Verifying Mean</u>	<u>Verifying T-Statistic</u>
2	Conductivity	1347	1900	2.75	2100	2.63
3	Conductivity	1347	9000	37.99	9600	28.79
4	pH	7.53	11.37	26.38	10.63	14.98
4	Conductivity	1347	4075	13.35	6600	13.33
4	TOH*	0.099	0.2303	11.19	0.115	1.05
						42.552 42.552

\*Lab Error, reported to TDWR 8/31/83



Well #3 is bounded on two sides by saltwater and the completion zone is below mean sea level. This well yields high conductivity fluids. The fluids may be from intake channel seeping down the well annulus. Since there are no surface or casing elevations (MSL) available, it is impossible to develop ground-water flow direction and rates. It can be estimated, based upon regional information, that the flow is to the southeast, but until surveying of reference points, there can be no definitive conclusions reached.

Well #4 has a very high pH value of 11.37. This value is reported to be higher than the wastes in the retention ponds which is approximately 10. The high value in the fluids from the monitor well may be a result of a reaction between the cement grout in the casing/hole annulus and the ground water. Another source would be caustic used in the neutralization circuit.

In summary, without elevations of monitor wells, ponds, pond fluid levels, ditches, and other ancillaries, it is impossible to determine ground-water movement. All wells must be fully developed to remove potential drilling-induced contaminants and resampled along with all surface fluids to provide accurate data to make comparisons. The methodologies used to develop these data are addressed below in the Ground-water Quality Assessment Program.



## GROUND-WATER ASSESSMENT PLAN

### Ground-water Characterization

Ground-water Levels: In order to determine the rate and direction of migration of any hazardous waste from the ponds and lagoons, the elevation of the water table must be known. A review of the plant records indicates that the elevation of the monitor well casing tops has never been established. In addition to making a determination of the direction of movement (in a lateral direction), a determination must be made as to the potential for movement in a vertical direction. As discussed in Site Description Section, Gulf Coast sediments are interbedded and many different water-bearing strata exist. Most have different piezometric surfaces. The difference in water levels controls the vertical migration rates. The following activities are proposed to characterize water levels:

- Establish the elevation of each monitor well top, plant water supply well top, and the water level in the ponds, lagoons, and other potential sources of seepage;
- Measure water levels in monitor wells and water wells;
- Draw a water table map of the shallow ground-water system;
- Determine the interrelationship, if any, between water levels in deep wells, monitor wells, and surface seepage sources; and
- Establish a base map of the facility from an aerial plant survey.

Area Use Characterization: During the plant inspection, several on-site water wells were noted. Generally these wells were completed at depths greater than 600 feet. Electric logs of the wells indicate that several shallower sands exist. Generally, domestic wells are completed in these shallower sands. The wells should be inventoried to determine





the potential for impacts. The following tasks will be performed:

- Establish a base map (7.5 minimum topographical base) for a 2.5 mile radius of the plant;
- Search the records of the TDWR for water well data;
- Search the files of the Houston office of the USGS for water well data;
- Contact the HGCSCD for additional water well data;
- Perform an on-the-ground survey within 1 mile of plant for domestic wells not recorded by government agencies;
- Prepare a table of water well data indicating owner, depth, and screened interval; and
- Prepare a table of regional water quality based upon analysis of water samples from wells located in the above task.

#### Well Stimulation

According to a report by McClelland Engineers, Inc., the monitor wells were drilled with a mud rotary drilling rig using a 7-inch diameter bit. After drilling to total depth, a 4-inch diameter PVC casing with 0.02 inch wide slots was run, and filter sand was backfilled across the monitoring zone. A one-foot layer of bentonite was installed on top of the filter sand to isolate the zone. Soil cuttings were then placed in the hole-casing annulus to within 4 feet of the surface. Cement was then placed in the well to grout the hole to ground level. The well was then jetted with air for an unknown period of time to clean the well.

In using mud rotary systems, significant amounts of water are lost to the permeable sections (sand, silty sands). This volume, based upon experience in drilling in the area, may be as high as 300 gallons. Observations made by the HL&P personnel sampling these wells indicate the wells are producing cloudy fluids suggesting the presence of



drilling fluids. The samples yielded to date may not be representative of formation fluids.

As part of the ground-water quality assessment, all wells will be jetted until field measurements such as pH and conductivity have stabilized and the effects of drilling fluids have been removed. The total volume evacuated may need to be as high as 400 gallons. This procedure will increase the probability that all future samples are representative of in situ conditions, and the possible effects of well completion contaminants are removed.

#### Sampling

Well Sampling: After all wells are jetted to enhance the removal of drilling-induced contaminants, water samples will be taken. A review of previous sampling indicates the absence of metals and organics. These parameters are not accurate indicators because there is attenuation of these substances in a clay-rich environment. After reviewing the nature of the waste fluids, it appears that more meaningful parameters will be the inorganic salts. All monitor wells will be sampled, using procedures outlined in Appendix B, for calcium, magnesium, potassium, sodium, carbonate, bicarbonate, chloride, sulfate, silica, conductivity, total dissolved solids, alkalinity, and pH. The sample results will be checked to ensure that complete and accurate sample results are obtained. The top part of the TDWR standard ground-water form will be used to report the data. The results will then be reviewed with the hydrologic data developed as described in the Hydrologic Data Acquisition Section to develop a picture of the geochemical/hydrologic characterization of the facility. These data then will be compared with samples from the ponds to determine whether impacts are present.

Ponds and Other Surface Water Samples: Ponds and other potential





seepage sources samples will be collected at the same time as the ground-water samples and analyzed, using procedures outlined in Appendix B, for calcium, magnesium, potassium, sodium, carbonate, bicarbonate, chloride, sulfate, silica, conductivity, total dissolved solids, alkalinity, and pH. The results will be reviewed to ensure accurate analyses have been conducted. These results will be compared numerically and graphically with the inorganic ground-water samples. From this review, possible impacts as a result of seepage can be determined.

Within the Ground-water Quality Assessment Plan, it is intended that a more parameter-specific analytical program be utilized to evaluate the significance of the variations in indicator parameter concentrations with respect to both hazardous waste/hazardous waste constituent migration (for compliance with TAC 335.194(d)(4)) as well as a general ground-water quality impact. As indicated previously, a review of the interim status Part A indicates that the hazardous waste streams which potentially flow to the waste management facilities are listed as hazardous based only on the pH value.

The Ground-water Quality Assessment Plan will therefore implement a specific analytical program which will have the following objectives:

- Verify whether variations in indicator parameter concentrations represent the migration of defined hazardous waste constituent, pH, to the ground-water system.
- Determine, based on analysis of materials present within the hazardous waste facilities, specific inorganic parameters which can be utilized in evaluating the significance of variations within the monitor wells.

In developing the analytical program, the selection of specific



inorganic parameters for analysis will depend on the following two factors.

- The potential for retardation of movement of the inorganic parameter within the ground-water system, and
- The initial concentration of the inorganic parameter within the facility.

#### Hydrologic Testing Details

Shallow Aquifer: In order to determine the rate and direction of movement, the permeability of the aquifer must be known. During the various soil boring programs around the plant, lab permeability tests were performed on many samples. However, no analyses were performed on the sandy strata. Therefore, field permeability tests will be performed on the monitor wells. Two separate methods may be utilized depending upon the recovery rate. These are described below:

Recovery Test: In this test, a predetermined volume of water will be evacuated from the well and the rate of recovery recorded. Data will be plotted as recovery in feet vs time.

Pump-in Test: This test method is the reverse of the recovery test. A predetermined volume of water is poured into the well casing and the length of time for the water level to decline to its original position is measured. Feet of decline versus time is plotted on an x-y coordinate plane.

Test Results: After the test data are plotted, several graphical solutions to the value of transmissivity are possible. Both the Bower and Rice Method and the Papadopoulos and Cooper Method will be utilized. The value of permeability will be obtained by dividing the screened interval thickness into the transmissivity value determined to obtain



permeability.

Deeper Aquifer: No specific field testing is proposed for the deeper zones. However, on the plant production wells, aquifer yield and performance testing was performed when the wells were installed. This data can be used to determine the specific capacity which can be used to estimate transmissivity.

Rates and Direction of Movement: In order to calculate the rates and direction of movements, the following factors are required: permeability, gradient, and porosity. The ground-water gradients and permeability will be determined as explained above. For the purpose of the assessment plan, a conservative porosity of 25% was utilized (generally Gulf Coast sediments indicate a 30 to 40% porosity for silty sands and clays). The following formula will be utilized:

$$V = \frac{K}{\emptyset} \times I, \text{ where}$$

V = average velocity of a contaminant; K = permeability;  $\emptyset$  = porosity expressed as a decimal; and I = gradient (dimensionless). Although this simplistic formula cannot take into account dispersion, adsorption, etc., it is a useful approximation as a first cut. Both horizontal and vertical rates of migration will be determined.

#### Geologic Cross Sections

In order to quantify the potential for subsurface migration of fluids, geologic cross sections based upon core borings will be prepared. There are numerous soil boring records available from plant construction activities. These logs will provide an accurate definition of the near-surface stratigraphy. A three dimensional system of the geologic setting will be developed, and the hydrogeologic framework will be integrated to use as a predictive tool for potential remedial action.





### IMPLEMENTATION SCHEDULE

In order to collect accurate and meaningful data, a phased approach must be undertaken. (1) All wells and ground surface elevations must be collected. (2) Existing ground-water elevations then must be collected and corrected to MSL. (3) The wells then must be jetted clean and representative samples collected from the wells, ponds, and other ancillaries. (4) Analytical tests must be conducted. (5) The hydrologic regime, and (6) geologic framework must be constructed and interfaced. (7) From this information, a summary can be prepared. The time table for these steps is outlined in Table 3.



TABLE 3

Ground-water Assessment Program Time Table

<u>Item</u>	<u>Time</u>
(1) Surveying all wellheads, ground levels, normal pond levels, and ancillaries	4 days
(2) Well Jetting	6 days
(3) Sampling of wells, ponds, and other ancillaries	2 days
(4) Analytical results	30 days
(5) Preparation of the hydrologic setting	12 days
(6) Preparation of the geologic setting	12 days
(7) Summary Preparation and Final Report	20 days
(8) Critical path items (1)+(2)+(3)+(4)+(7)	Total 62 working days or 90 calendar days



## FINAL REPORT AND RECOMMENDATIONS

At the conclusion of the Ground-water Quality Assessment Program, a final report will be prepared and submitted to the Texas Department of Water Resources.

The report will contain all data and descriptions of all field activities at the plant. The following minimum maps will be prepared and included in the report:

- Base Map with all data points indicated;
- Water Table Map with direction of ground-water movement for the uppermost aquifer;
- Geologic cross section through the plant showing all identifiable aquifers; and
- Topographic Map showing all known and inventoried water wells within one mile of the facility.

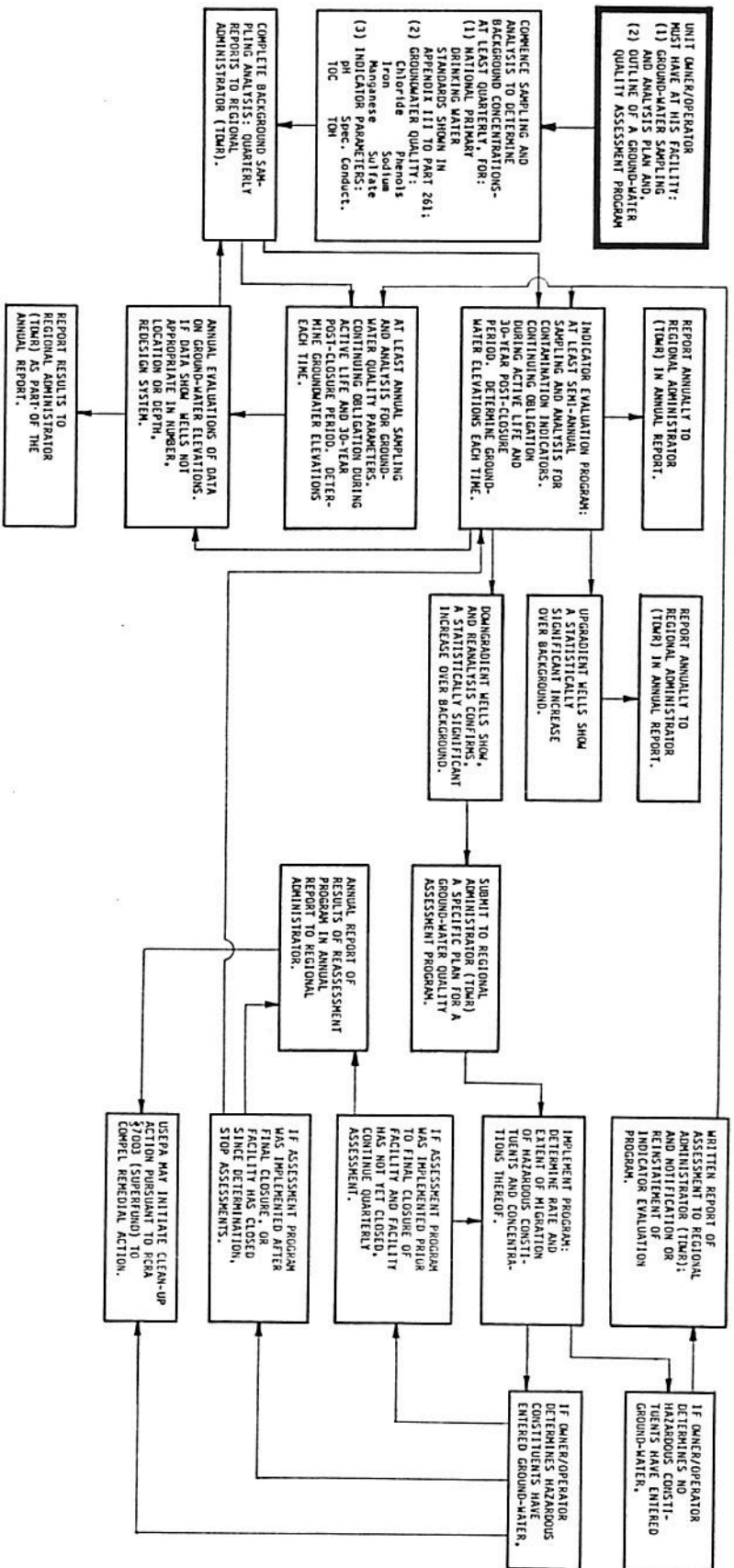
The following minimum tables will be presented:

- Aquifer Characteristics;
- Chemical Analyses; and
- Elevation of Wells.

All of the data will be analyzed and an opinion formulated as to the occurrence or non-occurrence of seepage from the facility. If seepage has occurred, the lateral and vertical depth of migration will be estimated. If additional wells are deemed necessary, their location and construction methods will be documented.



APPENDIX A  
Ground-water Monitoring Requirements for  
Hazardous Waste Facilities  
During Interim Status



# Appendix A

## GROUND-WATER MONITORING REQUIREMENTS FOR HAZARDOUS WASTE FACILITIES DURING INTERIM STATUS (BASED ON §335, 181(b) OF TDNR RULES)





APPENDIX B  
Analytical Methods



## APPENDIX B

### Analytical Methods

All samples obtained for monitoring should be analyzed in accordance with approved EPA methods listed below:

<u>Parameter</u>	<u>Method</u>	<u>Reference</u>	<u>Description</u>
Conductivity	120.1	1	Conductometric
pH	150.1	1	Electrometric
Total Dissolved Solids	160.1	1	Gravimetric
Alkalinity	310.1	1	Titrimetric
Chloride	325.3	1	Titrimetric
Fluoride	340.2	1	Potentiometric
Nitrate/Nitrite	353.3	1	Colorimetric
Sulfate	375.4	1	Turbidimetric
Calcium	215.1	1	AA/Aspiration
Iron	236.1	1	AA/Aspiration
Magnesium	242.1	1	AA/Aspiration
Potassium	258.1	1	AA/Aspiration
Carbonate	310.1	1	Titrimetric
Bicarbonate	310.1	1	Titrimetric
Silica	320.1	1	Colorimetric
Copper	220.1	1	AA/Aspiration
Zinc	289.1	1	AA/Aspiration
Sodium	273.1	1	AA/Aspiration



1. EPA 600/4-79-020, March 1979, "Methods for Chemical Analysis of Water and Wastes".
2. EPA SW 846, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods".
3. EPA Interim Method, November, 1980, "Interim Method for Total Organic Halide".
4. APHA/AWWA/WPCF, 15th Edition, "Standard Methods for the Examination of Water and Wastewater".